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Qualitative improvement of wool fiber through enzymatic scouring

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Abstract
Treatment with enzymes is an emerging field of science which has found various applications for the textile wet processing. Enzymes modifies the surface properties of textiles which act favourably for other finishes. The enzymatic treatment of wool fiber improves their physical properties as well as increases their aesthetic values. The present study was carried out to study the effect of various concentrations of the proteolytic enzymes. It was seen that in the presence of enzymes the whiteness of the bleached wool increases. Tibetian wool fibers were selected for the present study. The wool fibers were given simple scouring and enzymatic scouring treatment. Wool fibers were treated with various concentrations (i.e.4%, 8% and 12%) of pepsin, papain and Trypsin enzymes. Afterwards, the untreated and treated wool samples were tested for their physical properties. It was found out that the enzymes and their variable concentrations affected properties of the fibers i.e. weight loss, tenacity, elongation and whiteness index. From the results obtained it can be concluded that enzymatic treatment leads to improvement in properties of the fibers.

Keywords: Enzymes, wool fibres, scouring, proteolytic enzymes

Introduction
Enzymes are biological molecules with a definite structural organisation [1]. Enzymes are organic proteinaceous catalysts produced by all living cells. They are specialised protein composed of 200-250 amino acids that function in the acceleration of bio-chemical reactions: therefore it is also called as bio-catalysts [2].Textile processing depends a lot on the wonderful enzymes such as Amylases, Pectinase, Catalase, Lipase and Protease. Enzyme are completely biodegradable, environment friendly and does not leave any pollutant. Treatment with enzymes is an emerging field of science which has found various applications for the textile wet processing. Enzyme modifies the surface properties of textiles which act favourably for dye uptake and other finishes. In the present study an attempt was made to treat wool fibers with various concentrations of proteolytic enzymes and to assess the impact of enzymes on physical properties of wool fiber. Hence the present study was planned out with following objectives:

1. To treat wool fibers with various concentrations of proteolytic enzymes.
2. To study the simple and enzymatic treatment on physical properties of wool.

Methodology
The present study was conducted to assess the effect of enzymes on wool. Tibbetian wool was procured from Riverview factory Almora, Uttarakhand and three proteolytic enzmes i.e. Pepsin, Papain and Trypsin were purchased from M/s S.D. fine chemicals limited. The wool fiber was scoured by ezee and enzymes. The enzymatic scouring was done by taking three concentrations of enzyme viz., 4%, 8% and 12%. Scouring was done using by method described by Nation *et al.* (1997) [3]. Hundred gram of wool fiber was soaked in 4.5 L of water for three minutes at 36± 2^0 C. Then the sample was transferred to the soap solution of 4.5 L containing 5 ml of ezee for 15 minutes occasionally stirring was done. The sample was removed from soapy solution and washed thoroughly in water till all the soap was removed. Washed sample was again steeped in fresh soapy solution for 4 times the wool was free from all grease and dirt substances by reducing quantity of soap every time by one ml. Luke warm water was used to rinse sample in the process of scouring. Excess water was squeezed softly and then treated wool was dried in shade.
Scouring of wool with enzymes was done by taking three concentration of the enzymes i.e. 4,8 and 12 percent were taken o.w.f. The material liquor ratio 1:30.

Sodium carbonate weighs about 0.50 grams was added to one liter of solution and pH was maintained at 7. Sample was soaked in the solution for one hour at 55^0C, 45^0 C and 30^0 C for papain, pepsin and trypsin enzymes respectively. After one hour the enzyme activity was destroyed by raising the temperature of the liquor to 90^0 C. The sample were taken out from solution, washed thoroughly in water and dried in shade. Then samples were subjected to physical testing like weight loss, strength and elongation, microscopic appearance and whiteness index.

Results and Discussion

The work was carried out to see the effect of enzymatic treatment on wool. Evaluation of the physical properties of wool was made before and after simple and enzymatic scouring. It is evident from the results in tables 1 to 5 that there is significant variation in the fabric properties after the enzymatic treatment.

Physical properties

Weight loss

The weight of the experimental fiber were measured before and after enzymatic treatment of wool. Table 1 to 3 show weight loss of wool after enzymatic treatment and table 4 to 6 show weight loss of wool after bleaching. The average weight of fiber recorded before the treatment was 200g which was decreased after enzyme treatment. In case of pepsin the percent weight loss of the treated fibre at 4%, 8%, 12% concentration was 29.8, 35, and 39.7 respectively. For papain it was 31.0 percent, 31.4 percent and 49.2 percent respectively and trypsin treated fibre it was 29.7 percent, 34.1 percent and 54.5 percent respectively. It is evident from table 1 to 3 that enzymatic treatment caused weight loss. Maximum 54.5 percent weight loss was observed at 12% concentration of enzyme trypsin. According to Mehra *et al* (1999) an effective enzymatic treatment leads to weight loss [5].

Table 1: Effect of enzymatic scouring treatment with Pepsin on physical properties of wool fibers

S. No.	Fiber properties	Control	Concentration of enzyme (%)		
			4.0	8.0	12.0
1	Weight loss (%)	37.00	29.80	35.00	39.70
2	Tenacity (g/denier)	1.32	1.29	1.285	1.27
3	Elongation (%)	40.36	40.10	39.50	39.10
4	Whiteness index	1.00	3.10	4.10	4.40

Table 2: Effect of enzymatic scouring treatment with Papain on physical properties of wool fibers

Sl. No.	Fiber properties	Control	Concentration of enzyme (%)		
			4.0	8.0	12.0
1	Weight loss (%)	37.00	31.00	31.40	49.20
2	Tenacity (g/denier)	1.32	1.29	1.27	1.24
3	Elongation (%)	40.36	35.04	34.39	34.30
4	Whiteness index	1.00	5.60	7.16	7.43

Table 3: Effect of enzymatic scouring treatment with Trypsin on physical properties of wool fibers

Sl. No.	Fiber properties	Control	Concentration of enzyme (%)		
			4.0	8.0	12.0
1	Weight loss (%)	37.00	29.70	34.10	54.50
2	Tenacity (g/denier)	1.32	1.23	1.21	1.20
3	Elongation (%)	40.36	34.72	34.42	32.79
4	Whiteness index	1.00	4.53	5.16	6.96

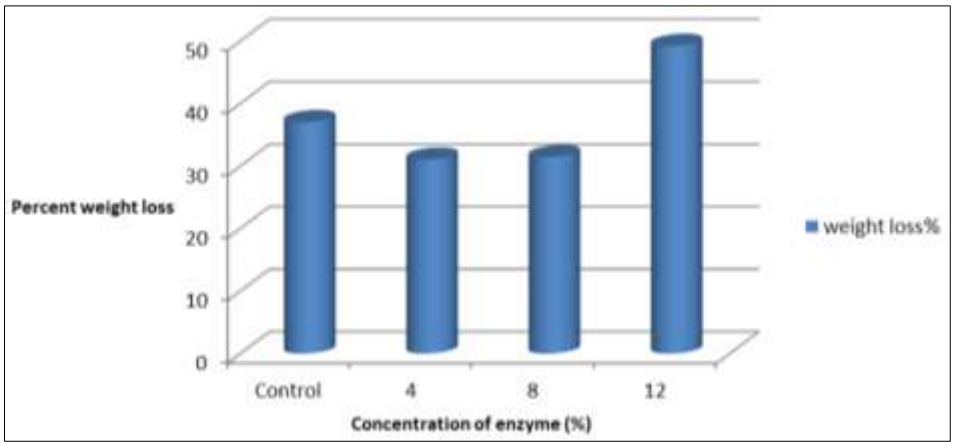

Fig 1: Effect of enzymatic scouring treatment with Papain on percent weight loss of wool fibers

Fiber strength

The tenacity recorded for untreated wool 1.34 g/denier, for control wool it was 1.32 g/denier. The tenacity of the fiber was found to be reduced after the enzymatic It is evident from table 1 to 6 that as the enzyme percentage was increase, the strength decreased. It was observed in case enzyme pepsin treated wool fiber that at 4%, 8%, and 12% decrease in tenacity observed for enzyme pepsin was 1.29, 1.285, 1.27

g/denier, Whereas for papain, the average decrease was 1.29, 1.27 and 1.24 g/denier, respectively. From the above results loss in fiber strength observed for control wool was 1.32 % and percentage loss in fiber strength observed for all the three enzymes ranged from 1.29 to 1.20. The percent loss in fiber strength for Pepsin, 1.29 to 1.27, for Papain it was 1.29 to 1.24 and 1.23 to 1.20 for Trypsin. Maximum loss in fiber strength was observed in case of enzyme trypsin. The loss in fiber strength was caused was caused due to partial destruction of the cysteine linkage present in wool due to enzymatic action. Thus the covalent bonds were paralysed and therefore a fiber strength loss was observed.

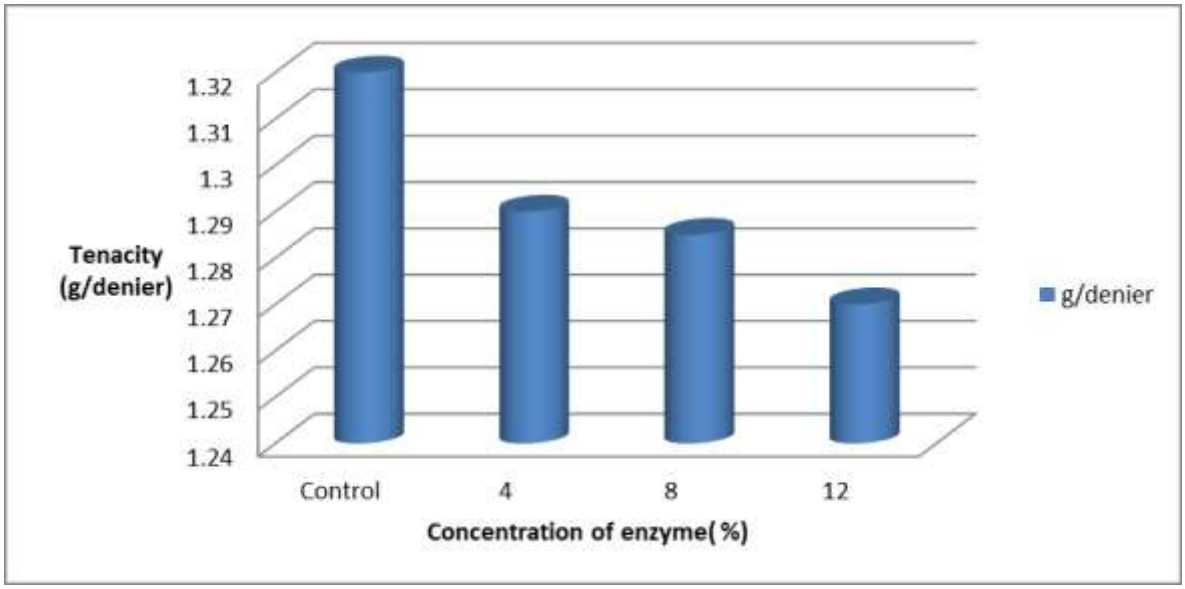

Fig 2: Effect of enzymatic scouring treatment with Pepsin on tenacity of woolfibers

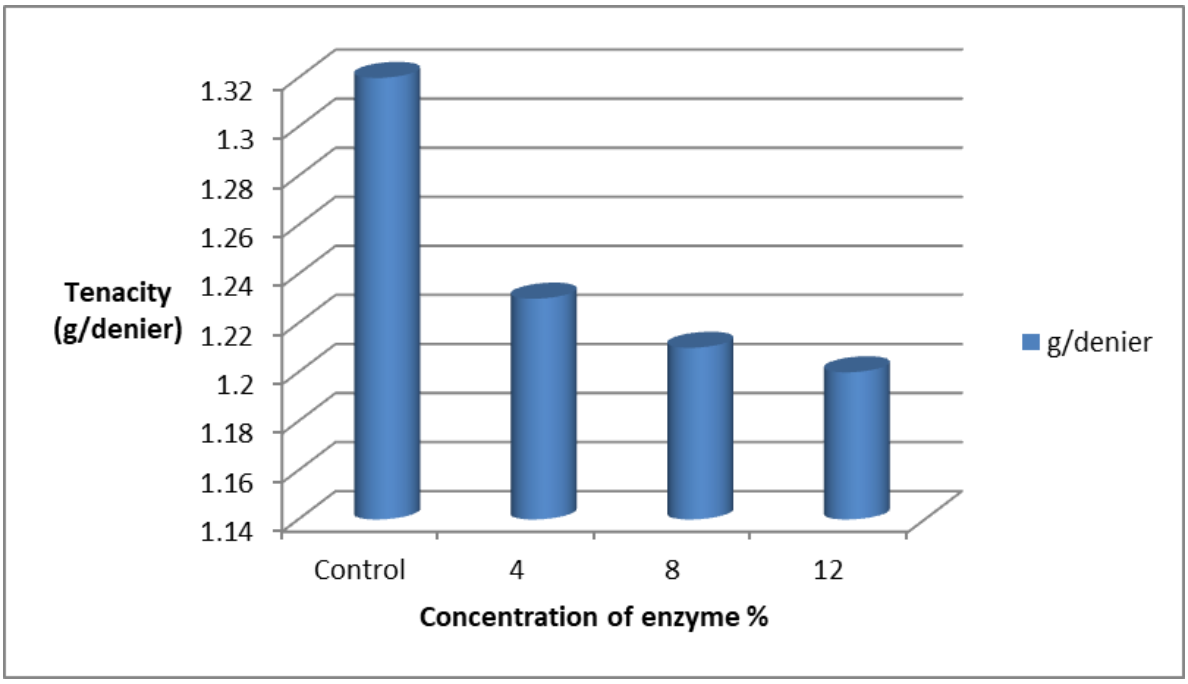

Fig 3: Effect of enzymatic scouring treatment with Trypsin on tenacity of wool fibers

Elongation at break

Average elongation percent of the untreated wool fiber recorded was 40.98% the elongation at break of the fiber was observed to decrease after the enzymatic treatment. From table 1 to 5 it is clear that as the enzyme concentration was increased at 4%, 8%, 12% the elongation percentage was reduced. The decrease in elongation percentage for these concentrations was 40.1%, 39.5% and 39.1% respectively for pepsin and 35.04%, 34.39% and 34.30% respectively for papain. Maximum decrease in elongation percentage was observed in case of trypsin i.e.34.72%, 34.42% and 32.79 %respectively**.** The percentage decrease in elongation at break observed for all the three enzymes ranged from 40.1% to 39.10% for pepsin from 35.04% to 34.3% for papain and from 34.72% to 32.42% for trypsin, respectively.

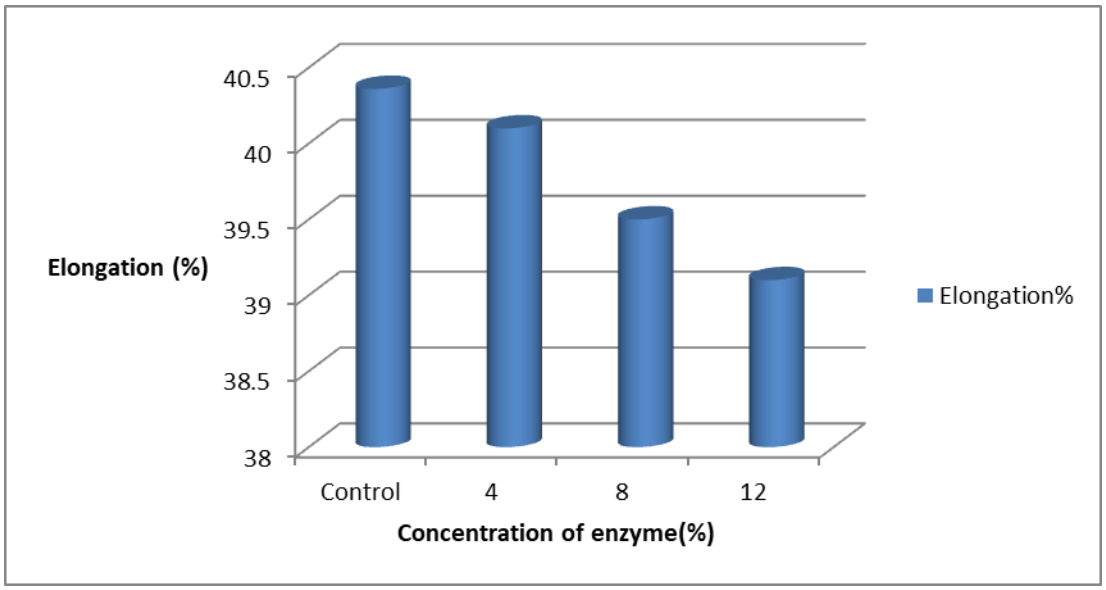

Fig 4: Effect of enzymatic scouring with Pepsin on elongation % of wool fibers

Whiteness Index

Whiteness index of the wool was measured in order to study the effect of enzymatic treatment on bleaching property of the fabric. It is evident from table 1 to 5 that whiteness index of the wool fiber after simple scouring was 1.0 which was found to improve after the enzymatic treatment. At 4.0% concentration of enzyme whiteness index was increased. In case of enzyme pepsin, papain and trypsin at 4.0% concentration of enzyme it was 3.1, 5.6 and 4.53 respectively. As the concentration of enzyme was increased i.e. 4%, 8%, 12% whiteness index also increased for pepsin it was 3.1, 4.1, 4.4 respectively, For papain whiteness index increased as 5.6, 7.16 and 7.43, whereas for trypsin the whiteness index was 4.53, 5.16 and 6.96 respectively. Increase in the value of whiteness index indicated towards the whiteness of the fabric. Maximum increase in whiteness index was observed at 12% concentration of enzyme papain i.e.7.43 followed by at 8.0% concentration of papain enzyme i.e.7.16. Thus it can be concluded that enzymatic treatment has enhanced the whiteness index of the fabric.

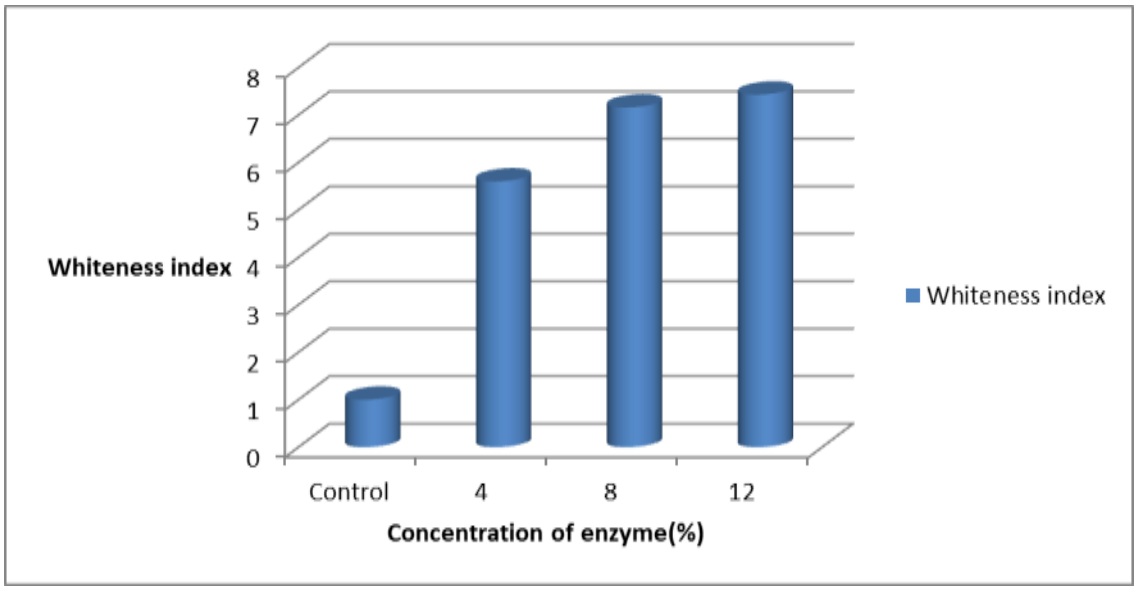

Fig 5: Effect of enzymatic scouring treatment with papain enzyme on whiteness index of wool fiber

Microscopic Appearance

In the microscopic view of Tibbetian wool fibers, it was found that the fiber surface was covered with overlapping scales like that of fish with a prominent medulla inside before the enzymatic treatment (Plate-1) Medulla is normally about in fine wool and infrequent in improved medium wool. Medulla is normally about in fine wool and infrequent in improved wool. Medullation occur due to incomplete keratinisation in the fiber. The cortical cells disintegrated in the middle of the coarse fibers and with chemical modification produce a granular structure and occupy less volume compared to the complex cortex. They appear black in the microscopic view [6].

Summary and Conclusion

Enzymes have been used for many years in the textile industry for the de-sizing of the cloth, concerning the environmental related issues and the depletion of the eco-system with the use of their toxic chemicals in textiles, there has been an increasing interest in the use of enzyme to

produce specific finishing effect on a variety of textile. The use of enzyme in textile processing is totally an eco-friendly process as it leaves no carcinogenic effect in the eco-system. The present study is an endeavour in the direction, which deals with the enzymatic treatment of wool. In the microscopic appearance it was found out that infrequent modulation of fragmented type present in place of continuous modulation. Papain enzyme at 12% concentration was found to be the most effective of all the three enzymes. It was observed that at 12% concentration of enzyme maximum weight loss occured. It was observed that after the enzymatic treatment the fiber strength of wool fiber was found to be reduced. It was found that after the enzyme treatment the elongation percentage of wool was reduced. The whiteness index was found to be increased after enzymatic treatment. From the results obtained in the present study in can be concluded that enzymatic treatment leads to loss in fiber weight, textile strength elongation percentage but this should not be consider as the limiting factor for the use of enzyme in textile finishing as all the other fiber properties were found to be significantly improved. By going through the results obtained, it can be concluded that papain enzyme has the maximum effect on fiber properties with all the concentrations, Papain enzyme may be found to be the best enzyme at all concentration i.e.4%, 8%,12% to be used in further in the finishing of wool.

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